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WILDLIFE CONSERVATION AND BIODIVERSITY SECTION

Inventory of Western Spiderwort (*Tradescantia occidentalis*) in Alberta, 2002

Alberta Species At Risk Report No. 61

Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

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Inventory of Western Spiderwort (*Tradescantia occidentalis*) in Alberta, 2002

Sue Peters

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TABLE OF CONTENTS

Acknowledgements.....vii

Executive Summary.....viii

1.0 Introduction..... 1

2.0 Study Area..... 2

3.0 Methods..... 2

4.0 Results..... 5

5.0 Discussion..... 10

6.0 Management Implications and Future Directions..... 11

7.0 Literature Cited..... 13

Appendices..... 15

LIST OF FIGURES

Figure 1. Western spiderwort inventory locations in 2002: Pakowki Lake North (1), Pakowki Lake South (2), and Lost River (3). See Table 1 for more details of each location.....4

LIST OF PHOTOS

Photo 1. The habitat at patch 1.....6

Photo 2. The habitat at patch 2.....6

Photo 3. The habitat at patch 3.....7

Photo 4. The habitat at patch 4.....7

Photo 5. The habitat at patch 5.....8

Photo 6. The habitat at patch 8, looking north to patches 9-14.....8

Photo 7. The habitat at patches 9-14.....9

Photo 8. The habitat at patch 15.....9

LIST OF TABLES

Table 1: Description of western spiderwort inventory locations within the study area in southeastern Alberta.....3

LIST OF APPENDICES

Appendix 1: Summary of the 2002 western spiderwort inventory data for Alberta.....15

Appendix 2: Monthly total precipitation (mm) for Medicine Hat, Manyberries and Onefour, Alberta, in years that western spiderwort has been inventoried (1986, 1987, 1990, 1999, 2001, 2002).....16

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EXECUTIVE SUMMARY

Alberta Sustainable Resource Development (Fish and Wildlife Division), together with the Alberta Conservation Association, initiated an inventory of western spiderwort (*Tradescantia occidentalis*) in southeastern Alberta in July 2002. The objective of this inventory was to provide an updated population estimate for western spiderwort in Alberta, which has been recommended by the Alberta Endangered Species Conservation Committee as Endangered. The only known population at the Pakowki Lake Sandhills near Manyberries was surveyed, as well as the surrounding habitat. Two other locations with suitable habitat in southeastern Alberta were also surveyed, including the sandhills southeast of Pakowki Lake, and those close to Onefour (near the Lost River). Other potential western spiderwort habitat in Alberta was searched in 1987 (Wallis and Wershler 1988), but could not be searched again in 2002.

The presence of western spiderwort was confirmed only at the Pakowki Lake Sandhills near Manyberries. A large number of plants was found at this location, so only a portion of the total population could be counted, while the remainder was extrapolated using GPS polygons. A total of 1,255 plants (defined as clumps of multi-stemmed shoots, based on Smith 2001a) was counted, and the total Alberta population was estimated to be approximately 7,450 plants (19,750 shoots). The small area where the previously known population was located contained only 16 of these plants (48 shoots). The population was scattered over an area of approximately 19,890 m^2 (area of occupancy of 0.02 km^2), based on the total area of the GPS polygons delineating patches of plants. Their extent of occurrence (the total area encompassing all patches of plants and the area between them) was approximately 2 km^2.

In 2002, western spiderwort plants had an average of 2.9 shoots per plant. On average, 95% of plants were reproductive (mean of 2.2 flowers per plant). Eighty-nine percent of the counted portion of the population had developing capsules (fruit structures), an indication of good seed production and future population potential. Browsing was patchy, ranging from 0-44% (average 15%) of plants within different patches. Browsing did not appear to be inhibitive for the population and was likely done primarily by native herbivores, because cattle had not yet (in 2002) been allowed to graze in most of the area where spiderwort was growing.

Precipitation records for Onefour, Alberta during the spring and summer of 2002 show much higher than average precipitation levels. The relatively large population of spiderwort close to that area this year seems to agree with previous observations that western spiderwort populations fluctuate with moisture. The population of western spiderwort seems to be resilient to at least short periods of drought in southern Alberta. More widespread inventories of western spiderwort need to be conducted in Alberta in years of high spring moisture.

1.0 INTRODUCTION

Western spiderwort (*Tradescantia occidentalis*) is a perennial flowering plant with a slender stem and linear leaves. The flowers, which usually appear in early July, have rose to dark blue petals arranged in groups of three. The plant spreads through the production of seeds, and also through the development of roots on the stem. Western spiderwort's unusual name comes from the soft, stringy material that can be pulled from the broken ends of the stem. After exposure to air, this material hardens into a thread that appears similar to a cobweb (Kershaw et al. 2001).

Western spiderwort was one of the first plant species in Alberta to be assessed by the Alberta Endangered Species Conservation Committee (ESCC), and be recommended as Endangered under Alberta's *Wildlife Act*. This was prompted by concern over its small population in Alberta that is isolated from populations in the United States and Saskatchewan, its fluctuating population size, and the declining trend in the availability of its sand dune habitat. These concerns, as well as the threat of leafy spurge (*Euphorbia esula*) invasion in other parts of Canada, had already lead to its listing as Threatened by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1992 (Smith and Bradley 1990, COSEWIC 2002).

Alberta Sustainable Resource Development (Fish and Wildlife Division), together with the Alberta Conservation Association, initiated an inventory of western spiderwort in southeastern Alberta in July 2002. The objective of this inventory was to provide an updated population estimate for western spiderwort in Alberta, in order to support the development of an Alberta Recovery Plan. Alberta Sustainable Resource Development is obligated to prepare a Recovery Plan within twelve months of a species being designated as Endangered under the *Wildlife Act*.

In Alberta, western spiderwort is known to occur in only one area in the southeastern corner of the province – the Pakowki Lake Sandhills close to the town of Manyberries. A small population was first discovered here in 1986, and has been monitored sporadically since then (Smith 2001b). The size of the spiderwort population in this area has varied from year to year (although never known to exceed 210 plants), depending on moisture levels. A population trend has therefore been difficult to determine.

The western spiderwort population in Alberta has typically been associated with sand dune areas that have active (drifting) sand, where vegetation is relatively sparse (Smith 2001b). It has also been found in somewhat low areas among the dunes, growing close to drought-resistant grasses, shrubs and trees. In Manitoba, however, botanists have found that the species will also grow in meadows (amongst low shrubs) and in shaded habitat (Goulet and Kenkel 1997).

In Canada, western spiderwort is at the northern limit of its range. Besides the population in Alberta, it is found at one location in southern Saskatchewan and at three sites in southwestern Manitoba (Smith 2001a, Goulet and Kenkel 1997, Hughes 2001). The populations in Alberta and Saskatchewan are widely separated from each other (by approximately 350 km) and from the nearest populations in the United States. The Manitoba populations are connected with the plant's main distribution throughout the central United States, where the species is common and often used as a horticultural species (for example, see Prairie Moon Nursery 2002).

2.0 STUDY AREA

Western spiderwort is found in the Dry Mixedgrass Subregion of the Grassland Natural Region, the warmest and driest subregion of Alberta (Alberta Natural Heritage Information Centre 2002a). Inventories were conducted in the area containing the previously known population, as well as the surrounding habitat northeast of Pakowki Lake, near Manyberries (subsequently referred to as Pakowki Lake North; Figure 1; Table 1). Two additional locations with suitable habitat that were also surveyed, including the sandhills southeast of Pakowki Lake (subsequently referred to as Pakowki Lake South; Figure 1; Table 1), and sandhills close to Onefour, near the Lost River (Figure 1; Table 1). Alberta's Dry Mixedgrass Subregion contains other potential habitat for western spiderwort that was searched in 1987 (Wallis and Wershler 1988), but could not be searched again in 2002 because of time constraints.

3.0 METHODS

Before searches were conducted, seven different landowners/leaseholders were contacted to obtain land access permission. They all received a one-page leaflet on western spiderwort, outlining its biology and significance, with a picture of the plant and a short section on what they can do to help this species in Alberta. All landowners/leaseholders granted land access.

Searches were conducted between July 3rd and 12th, when western spiderwort is known to flower in Alberta (Alberta Natural Heritage Information Network 2002b, Smith 2001b). Searches were initially carried out in areas where plants have previously been recorded, in order to develop a search image. Within the immediate area of the known population, roughly parallel transects were walked, to maximize the potential for finding more spiderwort plants. Beyond the immediate area, meander searches were conducted, focussing on partially stabilized sandhill habitat.

A large number of spiderwort plants was found at Pakowki Lake North, so only a portion of the total population could be counted, while the remainder was extrapolated using GPS polygons. To prevent plants from being missed or counted twice, a small flag was placed beside each plant and then removed after it was counted. For each plant, the number of stems and any evidence of browsing were recorded, as well as whether or not it was a reproductive individual (ie. at least one flower, and/or at least one developing capsule). The number of flowers per plant and the number of developing capsules (fruit structures) per plant were recorded for a large subset of plants (n = 740). A "plant" is defined as a clump of multi-stemmed shoots, based on the definition used by Smith (2001a).

For those patches of plants that could not be counted, the boundaries delineating relatively continuous western spiderwort plants (ie. widely-scattered individuals were not included) were recorded using a Garmin XL GPS (global positioning system) unit. The boundaries of the counted patches of plants were also recorded by GPS unit, so that a density estimate could be calculated. The density of plants in the largest counted patch (~1,800 m^2) was used to

Table 1: Description of western spiderwort inventory locations within the study area in southeastern Alberta.

NAME	LOCATION	LEGAL	OWNERSHIP	TOPO MAP
Pakowki Lake North	West of hamlet of Manyberries	T5-R7-W4	most sections leased, a few sections deeded	72 E/7
Pakowki Lake South	Southwest of hamlet of Manyberries	T4-R6-W4	mixture of leased and deeded	72 E/7
Lost River	Southwest of Onefour, in the Onefour Research Substation	T1-R4-W4	all federal crown land	72 E/2

Figure 1: Western spiderwort inventory locations in 2002: Pakowki Lake North (1), Pakowki Lake South (2), and Lost River (3). See Table 1 for more details of each location.

extrapolate the number of plants within other patches. Using ArcView 3.0a, the area of uncounted patches was estimated, and the number of plants they contained was extrapolated from the density estimate. Any patches that were obviously less dense were noted while in the field, so that the resulting extrapolated number of plants was not artificially inflated.

The results of the 2002 inventory have been entered into the Alberta Natural Heritage Information Centre (ANHIC) database of element occurrences.

4.0 RESULTS

The presence of western spiderwort was confirmed only at Pakowki Lake North. A total of 1,255 plants was counted, and the total Alberta population was estimated to be approximately 7,450 plants (19,750 shoots). This is a significant increase from the 2001 estimate of 20 plants in late June (Reg Ernst, pers. comm.) and only seven in mid-July (Smith 2001a). The 2002 population estimate is also substantially larger than any other previous estimate, with the highest being 210 individuals in 1990, a very wet year (Smith 2001a, b). The small area enclosing the previously known part of the population contained only 16 of the plants (48 shoots) found in 2002, thus most of the 2002 spiderwort population was in new areas of the Pakowki Lake North study site. Details of the population data collected in 2002 are summarized in Appendix 1.

The population was scattered over an area of approximately 19,890 m^2 (area of occupancy of 0.02 km^2; see IUCN 2001), based on the total area of the GPS polygons delineating patches of plants. Their extent of occurrence (the total area encompassing all patches of plants and the area between them; see IUCN 2001) was approximately 2 km^2. ANHIC defines plant populations as being separated by roughly 1 km or more (K. Vujnovic, pers. comm.), so despite the large number of spiderwort plants found in 2002, they are considered to be part of a single population.

In 2002, western spiderwort plants had an average of 2.9 shoots per plant. On average, 95.2% of plants were reproductive (mean of 2.2 flowers per plant). Eighty-nine percent of the counted portion of the population had developing capsules (fruit structures), an indication of good seed production and future population potential. Browsing was patchy, ranging from 0-44% (average 15%) of plants within different subpopulations. These browsing data represent a minimum, because browsed plants were more difficult to see than those with flowers were.

Western spiderwort was found growing in a variety of sandy habitats, including partially active sand dunes and stabilized sandhills (see Photos 1-8). A few of the species associated with spiderwort included: needle-and-thread grass (*Stipa comata*), northern wheat grass (*Agropyron dasystachyum*), sand grass (*Calamovilfa longifolia*), June grass (*Koeleria macrantha*), indian rice grass (*Oryzopsis hymenoides*), blue grama grass (*Bouteloua gracilis*), rose (*Rosa sp.*), skeletonweed (*Lygodesmia* sp.), and wild begonia (*Rumex venosus*). (See Smith (2001b) for more detailed habitat description).

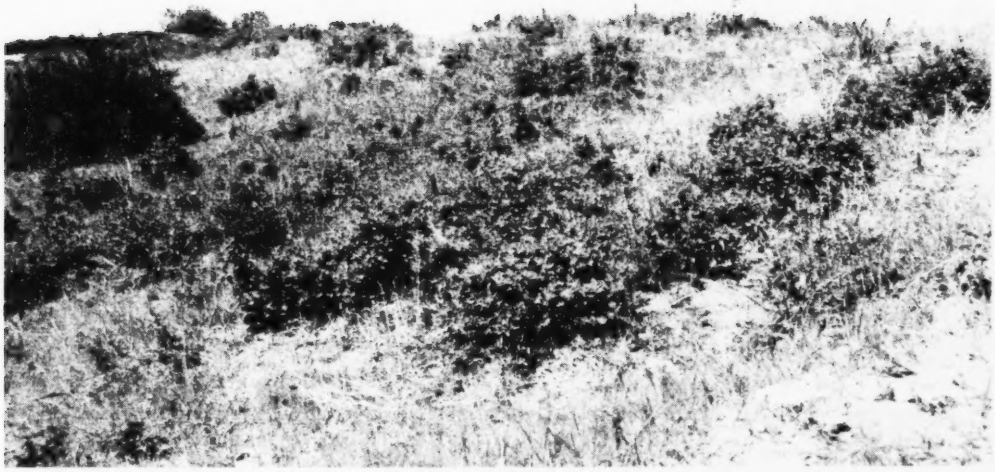

Photo 1: The habitat at patch 1. See Appendix 1 for information on each patch of plants.

Photo 2: The habitat at patch 2. See Appendix 1 for information on each patch of plants.

Photo 3: The habitat at patch 3. See Appendix 1 for information on each patch of plants.

Photo 4: The habitat at patch 4. See Appendix 1 for information on each patch of plants.

Photo 5: The habitat at patch 5. See Appendix 1 for information on each patch of plants.

Photo 6: The habitat at patch 8, looking north to patches 9-14. See Appendix 1 for information on each patch of plants.

Photo 7: The habitat at patches 9-14. See Appendix 1 for information on each patch of plants.

Photo 8: The habitat at patch 15. See Appendix 1 for information on each patch of plants.

5.0 DISCUSSION

The western spiderwort inventory conducted in 2002 recorded the largest known population estimate for this species in Alberta. Botanists have been visiting the Pakowki Lake North study area since the 1970s and have searched for spiderwort in stabilized, partially active and active sand dunes (C. Wallis, pers. comm.). We cannot rule out the possibility that some of the spiderwort plants found at Pakowki Lake North in 2002 were growing there in previous years; however, because none were found during any of the searches conducted there since the 1970s, this possibility cannot be confirmed. Considering that the 2001 inventory showed the lowest recorded population estimate as a result of extremely dry conditions, western spiderwort seems to be resilient to at least short periods of drought in southern Alberta, and rebounds in years with enough moisture.

The large 2002 population estimate is likely attributable to high spring moisture in southeastern Alberta. Despite the drought in some parts of the region this summer, the southern Prairies experienced the fourth wettest spring/summer in the period 1948-2002 (Environment Canada 2002a). Medicine Hat had 214% of the normal amount of moisture between May 1 and August 31, 2002, as compared to 1969-1990 data (Environment Canada 2002b). Precipitation records for Onefour, Alberta during the spring and summer of 2002 show much higher than average precipitation levels (Environment Canada 2002c, Appendix 2). Conversely, in years of low spring moisture few spiderwort plants have been found (e.g. 1987; see Appendix 2 and data in Smith 2001b). Low winter precipitation (snow cover) does not seem to be correlated with western spiderwort population size in Alberta (Appendix 2).

Over the long term, increased spring moisture may lead to greater vegetative cover and dune stabilization, which have been cited as threats to the persistence of western spiderwort (Smith 2001a). If loss of habitat to dune stabilization is indeed a threat, natural fluctuations in moisture (and hence spiderwort populations) may then be important to the sustainability of the population, by preventing sand dune habitats from becoming completely vegetated. However, many plants were found growing in stabilized sandhills amongst small shrubs, with high levels of flower and seed (capsule) production (e.g. see patch 8 in Appendix 1). In Manitoba, Goulet and Kenkel (1997) also found western spiderwort plants growing in semi-shaded habitats amongs shrubs or under canopy of bur oak, and noted that they appeared healthier and had high levels of seed production. This lead them to suggest that low shrub cover may be critical to the survival of western spiderwort.

Geowest Environmental Consultants Ltd. conducted a vegetation survey of the Pakowki sandhills in the summer of 2002, with the objective of establishing sand dune and sand plain community types in the Grasslands Natural Region. They did not encounter any western spiderwort during their survey (E. Anderson, pers. comm.). However, this was not a rare plant survey, and the plots were not established to inventory rare species.

No immediate threats to Alberta's western spiderwort population were evident during the 2002 inventory. Browsing did not appear to inhibit the population and was likely done primarily by native herbivores, since cattle had not yet (in 2002) been allowed to graze in most of the area where spiderwort was growing. Leafy spurge, which is a concern in western spiderwort habitat

in other jurisdictions (Goulet and Kenkel 1997, Hohn 1994, Smith 2001a), was not noted during the Alberta inventory. Nonetheless, because Alberta's spiderwort population is currently known only from a 2 km^2 area, local land-use decisions made by only a few leaseholders could have a significant impact on the population. The threat of conversion of spiderwort habitat to cropland is highly unlikely, given the erosive nature of the sandy soil (T. Hood, pers. comm.). Pakowki Lake North is leased for grazing. Low to moderate cattle grazing likely has limited impact on the western spiderwort population and may even prevent the sand dunes from becoming completely stabilized. Intensified grazing pressure may be a potential threat, however, not much is known about how spiderwort responds to grazing pressure. Long-term overgrazing may reduce reproductive potential of the population by eliminating or reducing the number of flowers on grazed plants (S. Peters, pers. obs.). There is currently no petroleum exploration or extraction in the area northeast of Pakowki Lake, and some public land in this area is protected from oil and gas exploration through reservations (a type of protective notation) (T. Hood, pers. comm.); however, this may become a concern for Alberta's spiderwort population in the future, as oil and gas companies continue to look for new areas to explore (T. Hood, pers. comm.).

The results of the 2002 inventory do not affect the status of western spiderwort under the Alberta *Wildlife Act*, but they might affect the criterion under which spiderwort qualifies as Endangered (IUCN 2001). When it was assessed in 2001 [using criteria developed by the World Conservation Union (IUCN)], it qualified for listing because of the population's very small size (<50 mature individuals). It is now known that the population can reach up to an estimated 7,450 individuals. If it is assumed that this is a result of a truly larger population in 2002 (rather than an artifact of having found plants that were missed in previous years), this just suggests that this species undergoes dramatic fluctuations in population size. If this is true, the IUCN guidelines recommend adopting a smaller number, closer to the minimum than to the maximum population size. Therefore a single higher population count does not, in itself, change the status. Moreover, such large fluctuations in population size, in combination with the small distribution and single known location would qualify this species under an additional IUCN criterion. Regardless of the criterion under which western spiderwort qualifies for listing, it would be good to continue monitoring the population to see if it remains above 50 individuals, or if the larger 2002 population was a short-lived, opportunistic expansion in a year of optimal growing conditions.

6.0 MANAGEMENT IMPLICATIONS AND FUTURE DIRECTIONS

In 1997, Alberta's *Wildlife Act* was amended to allow designation, protection and recovery of Threatened and Endangered plants. There is currently no national or provincial recovery plan in place for western spiderwort. Based on the success of the 2002 inventory, it is recommended that more widespread inventories are conducted in Alberta in at least one more year of high spring moisture, before significant resources and time are put towards a recovery plan. Our outlook on the future sustainability of western spiderwort in Alberta will be improved if it is known to occur in more than one site. Some other potential areas of sand dune/sandhill habitat in the southeastern corner of the province include: Purple Springs (northeast of the town of Purple Springs), Hilda (northwest of the town of Hilda), Middle sandhills (within C.F.B.

Suffield), and Lazy H (west of the town of Milk River). These and other sand dune areas in Alberta are described in Wallis and Wershler (1988).

After more widespread inventories are complete and more is known about western spiderworts' distribution in Alberta, a provincial recovery plan should be developed, to set goals, objectives, strategies, and actions needed to guide the management of this species over the next five years. The Alberta Endangered Species Conservation Committee has recommended to the Minister of Sustainable Resource Development that initial recovery efforts for this species should focus on the identification and conservation of the existing population(s), rather than the creation or reintroduction of new populations since the rest of the North American population appears healthy. These recommendations are outlined in the Initial Conservation Action Statement for western spiderwort (Alberta Endangered Species Conservation Committee 2001). Protection of all western spiderwort populations should be implemented to ensure that there are no losses as a result of industrial, agricultural or recreational activities. The possibility of applying an appropriate protective notation should be investigated.

The Scientific Subcommittee of the ESCC has identified areas of research that would help clarify some aspects of western spiderwort's biology that are relevant to its status in Alberta and the development of long-term management recommendations and strategies. These areas of research include: genetics (compare the genetic structure of the disjunct population in Alberta to that of populations at the core of the species range to find out how distinct the Alberta population is); seed bank (determine the role of the seed bank in maintaining this species as it fluctuates with moisture); and dune stabilization (determine if dune stabilization through a lack of disturbance is a threat to the persistence of this species). Manitoba has the largest population of western spiderwort in Canada, and has invested substantial research effort into this species (Goulet and Kenkel 1997, Hohn 1994, Hughes 2001). Alberta biologists will need to coordinate and consult with other jurisdictions regarding their management strategies for western spiderwort.

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Appendix 1: Summary of the 2002 western spiderwort inventory data for Alberta. Plants were recorded as being either in a patch (relatively continuous group of plants; not necessarily equivalent to subpopulations) or scattered individuals (see last row of data). All patches were considered part of a single population because they were separated by <1km (ANHIC definition of population). "N/a" indicates that the data are not available.

								% plants with # developing capsules:				
Patch [1]	**Approx. Area(m^2)**	**Method** [2]	**Total # Shoots**	**Total # plants** [3]	**Average # shoots/plant**	**% Reprod. Plants**	**Average # flwrs/plant**	**0**	**1-5**	**6-10**	**>10**	**% plants browsed**
1	50	counts	14	4	3.5	100	n/a	n/a	n/a	n/a	n/a	25
2	50	counts	5	3	1.7	100	n/a	n/a	n/a	n/a	n/a	0
3	<100	counts	29	9	3.2	89	n/a	n/a	n/a	n/a	n/a	44.4
4	488	counts	83	37	2.2	97	2.4	16.2	43.2	16.2	24.3	0
5	79	counts	45	11	4.1	91	1.5	9.1	72.7	9.1	9.1	9.1
6	1240	extrap.	992*	372*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
7	9683	extrap.	7746*	2905*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8 [4]	1818	counts	2896	1151	2.5	99.7	3.6	1.2	22.9	28.3	47.5	4.3
9	1364	extrap.	1091*	409*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
10	126	extrap.	202	76	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
11	1302	extrap.	2083	781	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
12	809	extrap.	1294	485	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
13	1898	extrap.	1518*	569*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
14	799	extrap.	1278	479	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
15	84	counts	114	40	2.9	90	1.3	17.5	47.5	27.5	7.5	22.5
Scattered individuals		estimate	363	125	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Counted sites only:			**3186**	**1255**	**2.9**	**95.2**	**2.2**	**11**	**46.6**	**20.3**	**22.1**	**15**
All sites:	**19,890**		**19,753**	**7456**								

[1] The distance between any 2 patches of plants ranged between approximately 50m and <1km. Patches 1-3 have been monitored since 1986.

[2] Plants in some patches were individually counted, while others were extrapolated from GPS boundaries.

[3] One plant is defined as a clump of multi-stemmed shoots.

[4] The density of plants in this patch (0.6 plants/m^2) was used to estimate (by extrapolation) the number of plants in other patches. In an effort to provide conservative population estimates, a lower density of plants (0.3/m^2) was used for the extrapolation for patches with notably lower density (noted in the field). Similarly, a stem density of 1.6/m^2 was used to estimate the number of stems at other patches; 0.8/m^2 was used for patches with notably lower density.

*Estimates based on lower density are marked with as asterisk (see explanation in footnote 4).

Appendix 2: Monthly total precipitation (mm) for Medicine Hat, Manyberries and Onefour, Alberta, in years that western spiderwort has been inventoried (1986, 1987, 1990, 1999, 2001, 2002). Data provided by Environment Canada, Commercial Weather Services Division.

Station	Year[1]	Jan.	Feb.	March	April	May	June	July
Medicine Hat	1986	31	90	268	57	840	829	572
Long-term Average	1951-80	227	166	185	302	401	635	404
Manyberries	1986	106	156	266	158	812	984	366
Long-term Average	1951-80	251	215	215	355	422	666	310
All stations average	**1986**	**68.5**	**123**	**267**	**107.5**	**826**	**906.5**	**469**
Long-term average	**1951-80**	**239**	**190.5**	**200**	**328.5**	**411.5**	**650.5**	**357**
Medicine Hat	1987	68	38	338	185	186	219	454
Long-term Average	1951-80	227	166	185	302	401	635	404
Manyberries	1987	61	84	305	60	272	352	672
Long-term Average	1951-80	251	215	215	355	422	666	310
All stations average	**1987**	**64.5**	**61**	**321.5**	**122.5**	**229**	**285.5**	**563**
Long-term average	**1951-80**	**239**	**190.5**	**200**	**328.5**	**411.5**	**650.5**	**357**
Medicine Hat	1990	146	34	208	228	552	286	464
Long-term Average	1951-80	227	166	185	302	401	635	404
Manyberries[2]	1990	98	66	160	382	685	204	376
Long-term Average	1951-80	251	215	215	355	422	666	310
All stations average	**1990**	**122**	**50**	**184**	**305**	**618.5**	**245**	**420**
Long-term average	**1951-80**	**239**	**190.5**	**200**	**328.5**	**411.5**	**650.5**	**357**
Medicine Hat	1999	204	10	22	366	590	767	231
Long-term Average	1961-90	173	103	160	260	423	564	409
Onefour[3]	1999	120	n/a[4]	n/a	422	364	494	230
All stations average	**1999**	**162**	**10**	**22**	**394**	**477**	**630.5**	**230.5**
Long-term average	**1961-90**	**173**	**103**	**160**	**260**	**423**	**564**	**409**
Medicine Hat	2001	76	106	96	80	92	302	220
Long-term Average	1971-00	137	93	183	248	460	626	406
Onefour	2001	4	n/a	n/a	n/a	218	326	394
All stations average	**2001**	**40**	**106**	**96**	**80**	**155**	**314**	**307**
Long-term average	**1971-00**	**137**	**93**	**183**	**248**	**460**	**626**	**406**
Medicine Hat	2002	71	142	206	102	416	185	498
Long-term Average	1971-00	137	93	183	248	460	626	406
Onefour	2002	n/a	n/a	332	86	610	1326	690
Short-term Average	1999, 2001	62	n/a	n/a	n/a	291	410	312

All stations average not calculated as a result of missing data.

[1] These are years that western spiderwort has been monitored.

[2] 1990 was the last year the Manyberries weather station was in operation.

[3] This station only opened in 1991; long-term precipitation averages are only available for stations with 15 years of data.

[4] n/a = not available

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